

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	NMI service identifier	Comments
DC voltage sources: single values	Solid state voltage standard	Null balance	1	1.018	V	Output voltage	1 V, 1.018 V	20	nV	2	95%	No		1	Approved on 18 October 2004
DC voltage sources: single values	Solid state voltage standard	Null balance	10	10	V			500	nV	2	95%	No		2	Approved on 18 October 2004
DC voltage sources: single values	Standard cell, solid state voltage standard	Difference measurement	1	1.018	V	Output voltage	1 V, 1.018 V	300	nV/V	2	95%	Yes		3	Approved on 18 October 2004
DC voltage sources: single values	Solid state voltage standard	Difference measurement	10	10	V			300	nV/V	2	95%	Yes		4	Approved on 18 October 2004
DC voltage sources: low values (<= 10 V)	Multifunction calibrator	Comparison with resistively divided voltage	0.01	1	mV			0.1	μV	2	95%	No		5	Approved on 18 October 2004
DC voltage sources: low values (<= 10 V)	Multifunction calibrator, voltage V	Comparison with resistively divided voltage	0.001	0.1	V			Q[0.05, V], V in volt	μV	2	95%	No		6	Approved on 18 October 2004
DC voltage sources: low value ranges (<= 10 V)	Multifunction calibrator	Comparison with resistively divided voltage	0.1	10	V			1	μV/V	2	95%	Yes		7	Approved on 18 October 2004
DC voltage sources: intermediate values (> 10 V to 1100 V)	Multifunction calibrator	Comparison with resistively divided voltage	10	1000	V			2	μV/V	2	95%	Yes		8	Approved on 18 October 2004
DC voltage meters: intermediate values (> 1 mV to 1100 V)	Multimeter, DC voltmeter, voltage V	Calibrator	0.001	10	V			(0.7 + 5V), V in volt	μV	2	95%	No		9	Approved on 18 October 2004
DC voltage meters: intermediate values (> 1 mV to 1100 V)	Multimeter, DC voltmeter	Calibrator	10	1000	V			10	μV/V	2	95%	Yes		10	Approved on 18 October 2004
DC voltage ratios: up to 1100 V	Resistive divider	Potentiometry	0.01	1		Maximum input voltage	1 kV	0.2	μV/V	2	95%	Yes		11	Approved on 18 October 2004
DC resistance standards and sources: low values (<= 1 Ω)	Fixed resistor	CCC bridge and DCC bridge	1	1	Ω	Oil bath temperature	25 °C	0.2	μΩ/Ω	2	95%	Yes		12	Approved on 18 October 2004
DC resistance standards and sources: low values (<= 1 Ω)	Fixed resistor	DCC bridge	0.1	0.1	mΩ	Oil bath temperature	25 °C	10	μΩ/Ω	2	95%	Yes		13	Approved on 18 October 2004
						Maximum power	0.1 W								
DC resistance standards and sources: low values (<= 1 Ω)	Fixed resistor	DCC bridge	1	100	mΩ	Resistance	1 mΩ, 10 mΩ, 100 mΩ	3 to 1	μΩ/Ω	2	95%	Yes		14	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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						Oil bath temperature	25 °C								
						Maximum power	0.1 W								
DC resistance standards and sources: intermediate values (> 1 Ω to 1 MΩ)	Fixed resistor	DCC bridge	10	1.E+04	Ω	Resistance	10 Ω, 100 Ω, 1000 Ω, 10000 Ω	0.3	μΩ/Ω	2	95%	Yes		15	Approved on 18 October 2004
						Oil bath temperature	25 °C								
DC resistance standards and sources: intermediate values (> 1 Ω to 1 MΩ)	Fixed resistor	DCC bridge	1.E+05	1.E+06	Ω	Resistance	1.E+05 Ω, 1.E+06 Ω	1 to 3	μΩ/Ω	2	95%	Yes		16	Approved on 18 October 2004
						Oil bath temperature	25 °C								
						Voltage	30 V to 50 V								
DC resistance standards and sources: high values (>1 MΩ)	Fixed resistor	Modified Wheastone bridge	10	10	MΩ	Air temperature	23 °C	6	μΩ/Ω	2	95%	Yes		17	Approved on 18 October 2004
						Maximum voltage	10 V								
						Relative humidity	45% or less								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Modified Wheastone bridge	100	100	MΩ	Air temperature	23 °C	9	μΩ/Ω	2	95%	Yes		18	Approved on 18 October 2004
						Maximum voltage	100 V								
						Relative humidity	45% or less								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Modified Wheastone bridge	1	1	GΩ	Air temperature	23 °C	12	μΩ/Ω	2	95%	Yes		19	Approved on 18 October 2004
						Maximum voltage	100 V								
						Relative humidity	45% or less								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Teraohmmeter	10	10	GΩ	Temperature	23 °C	810	μΩ/Ω	2	95%	Yes		20	Approved on 18 October 2004
						Relative humidity	55% or less								
						Voltage	100 V								

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Teraohmmeter	100	100	GΩ	Temperature	23 °C	1.2	mΩ/Ω	2	95%	Yes		21	Approved on 18 October 2004
						Relative humidity	55% or less								
						Voltage	100 V								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Teraohmmeter	1	1	TΩ	Temperature	23 °C	2.4	mΩ/Ω	2	95%	Yes		22	Approved on 18 October 2004
						Relative humidity	55% or less								
						Voltage	100 V								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Teraohmmeter	10	10	TΩ	Temperature	23 °C	5	mΩ/Ω	2	95%	Yes		23	Approved on 18 October 2004
						Relative humidity	55% or less								
						Voltage	200 V								
DC resistance standards and sources: high values (> 1 MΩ)	Fixed resistor	Teraohmmeter	100	100	TΩ	Temperature	23 °C	50	mΩ/Ω	2	95%	Yes		24	Approved on 18 October 2004
						Relative humidity	55% or less								
						Voltage	500 V								
DC resistance standards and sources: standards for high current	DC shunt	DCC bridge	1	100	mΩ	Current	100 A to 0.2 A	10 to 50	μΩ/Ω	2	95%	Yes		25	Approved on 18 October 2004
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Potentiometry	1	10	Ω	Resistance	1 Ω, 10 Ω	41 to 16	μΩ/Ω	2	95%	Yes		26	Approved on 18 October 2004
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Transfer via multimeters	0.1	1000	kΩ	Resistance	0.1 kΩ, 1 kΩ, 10 kΩ, 100 kΩ, 1000 kΩ	10	μΩ/Ω	2	95%	Yes		27	Approved on 18 October 2004
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Transfer via multimeters	10	100	MΩ	Resistance	10 MΩ, 100 MΩ	20	μΩ/Ω	2	95%	Yes		28	Approved on 18 October 2004
DC resistance meters: low values (<= 1 Ω)	Microhmmeters, resistance	Direct calibration	0.001	1	Ω			0.2 to 0.1	mΩ/Ω	2	95%	Yes		29	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Multimeters, resistance	Direct calibration	1.E+01	1.E+01	Ω			5	μΩ/Ω	2	95%	Yes		30	Approved on 18 October 2004	
DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Multimeters, resistance	Direct calibration	0.1	100	kΩ			3	μΩ/Ω	2	95%	Yes		31	Approved on 18 October 2004	
DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Multimeters, resistance	Direct calibration	1	1	MΩ			5	μΩ/Ω	2	95%	Yes		32	Approved on 18 October 2004	
DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Multimeters, resistance	Direct calibration	10	10	MΩ			8	μΩ/Ω	2	95%	Yes		33	Approved on 18 October 2004	
DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Multimeters, resistance	Direct calibration	100	100	MΩ			30	μΩ/Ω	2	95%	Yes		34	Approved on 18 October 2004	
DC resistance meters: intermediate value (> 1 Ω to 1 GΩ)	Teraohmmeter, resistance	Direct calibration	1	1	GΩ			70	μΩ/Ω	2	95%	Yes		35	Approved on 18 October 2004	
DC resistance meters: high values (> 1 GΩ)	Teraohmmeter, resistance	Direct calibration	10	1000	GΩ			2000	μΩ/Ω	2	95%	Yes		36	Approved on 18 October 2004	
DC resistance meters: high values (> 1 GΩ)	Teraohmmeter, resistance	Direct calibration	10	100	TΩ	Resistance	10 TΩ, 100 TΩ	3400 to 6000	μΩ/Ω	2	95%	Yes		37	Approved on 18 October 2004	
DC current sources: intermediate values (> 0.1 mA to 20 A)	Multifunction calibrator: DC current	Potentiometry	0.0002	2	A			6	μA/A	2	95%	Yes		38	Approved on 18 October 2004	
DC current sources: intermediate values (> 0.1 mA to 20 A)	Current generator	Potentiometry	2	20	A			10	μA/A	2	95%	Yes		39	Approved on 18 October 2004	
DC current sources: high values (> 20 A to 100 A)	Current generator	Potentiometry	20	100	A			160	μA/A	2	95%	Yes		40	Approved on 18 October 2004	
DC current meters: intermediate values (> 0.1 mA to 20 A)	Multimeters	Direct calibration	0.0002	2	A			20	μA/A	2	95%	Yes		41	Approved on 18 October 2004	
Capacitance: capacitance for low loss capacitor	Fused-silica standard capacitor	Ratio transformer bridge	10	10	pF	Frequency	1 kHz, 1.592 kHz	0.5	μF/F	2	95%	Yes		42	Approved on 18 October 2004	
Capacitance: capacitance for low loss capacitor	Standard capacitor	Ratio transformer bridge	1	1	pF	Frequency	1 kHz, 1.592 kHz	5	μF/F	2	95%	Yes		43	Approved on 18 October 2004	
Capacitance: capacitance for low loss capacitor	Standard capacitor	Ratio transformer bridge	10	1000	pF	Capacitance	10 pF, 100 pF, 1000 pF	1	μF/F	2	95%	Yes		44	Approved on 18 October 2004	

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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						Frequency	1 kHz, 1.592 kHz								
Capacitance: capacitance for dielectric capacitor	Fixed capacitor	Ratio transformer bridge	0.01	1	μF	Frequency	1 kHz, 1.592 kHz	50	μF/F	2	95%	Yes		45	Approved on 18 October 2004
Capacitance: dissipation factor for low loss capacitor	Fused-silica standard capacitor	Ratio transformer bridge	1.E-06	1.E-04		Frequency	1 kHz	5.E-06		2	95%	No		46	Approved on 18 October 2004
						Capacitance	10 pF								
Capacitance: dissipation factor for low loss capacitor	Standard capacitors	Ratio transformer bridge	1.E-06	1.E-04		Frequency	1 kHz	1.E-05		2	95%	No		47	Approved on 18 October 2004
						Capacitance	1 pF, 10 pF, 100 pF, 1000 pF								
Capacitance: dissipation factor for dielectric capacitor	Fixed capacitor	Ratio transformer bridge	1.E-06	1.E-04		Frequency	1 kHz	5.E-05		2	95%	No		48	Approved on 18 October 2004
						Capacitance	0.01 μF, 0.1 μF, 1 μF								
Inductance: self inductance and equivalent series resistance, low values (< 1 mH)	Fixed inductor	Comparison	100	100	μH	Frequency	1 kHz	350	μH/H	2	95%	Yes		49	Approved on 18 October 2004
Inductance: self inductance and equivalent series resistance, intermediate values (>= 1 mH to 1 H)	Fixed inductor	Comparison	1	1000	mH	Inductance	1 mH, 10 mH, 100 mH, 1000 mH	100	μH/H	2	95%	Yes		50	Approved on 18 October 2004
						Frequency	1 kHz								
Inductance: self inductance and equivalent series resistance, high values (> 1 H)	Fixed inductor	Comparison	10	10	H	Frequency	1 kHz	100	μH/H	2	95%	Yes		51	Approved on 18 October 2004
AC/DC voltage transfer: AC/DC difference at low voltages (typically <=0.5 V)	Thermal voltage converters	Comparison	0.2	0.5	V	Frequency	40 Hz to 1 MHz	15 to 40	μV/V	2	95%	Yes	Matrix AC-DC Voltage	52	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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AC/DC voltage transfer: AC/DC difference at intermediate voltages (typically 0.5 V to 5 V)	Thermal voltage converters	Comparison	0.5	5	V	Frequency	40 Hz to 1 MHz	3 to 35	µV/V	2	95%	Yes	Matrix AC-DC Voltage	53	Approved on 18 October 2004
AC/DC voltage transfer: AC/DC transfer difference at higher voltages (typically > 5 V)	Thermal voltage converters plus range extenders	Comparison	5	1000	V	Frequency	40 Hz to 1 MHz	5 to 50	µV/V	2	95%	Yes	Matrix AC-DC Voltage	54-66	Approved on 18 October 2004
AC voltage up to 1000 V: sources	Multifunction calibrator: AC voltage	AC/DC transfer	0.1	1000	V	Frequency	40 Hz to 1 MHz	40 to 335	µV/V	2	95%	Yes	Matrix ACV source	67	Approved on 18 October 2004
AC voltage up to 1000 V: meters	AC voltmeter, multimeter	Direct measurement	0.1	1000	V	Frequency	40 Hz to 100 kHz	61 to 655	µV/V	2	95%	Yes	Matrix ACV meter	68	Approved on 18 October 2004
AC voltage ratio, attenuation and gain: real component	Inductive voltage divider	Comparison with reference divider	0	1		Maximum rms voltage	25 V	2.E-07		2	95%	No		69	Approved on 18 October 2004
						Frequency	1 kHz								
AC voltage ratio, attenuation and gain: imaginary component	Inductive voltage divider	Comparison with reference divider	-0.001	0.001		Maximum rms voltage	25 V	5.E-07		2	95%	No		70	Approved on 18 October 2004
						Frequency	1 kHz								
AC/DC current transfer: AC/DC transfer difference	Thermal converter with shunt	Comparison	0.005	10	A	Frequency	40 Hz to 10 kHz	60 to 205	µA/A	2	95%	Yes	Matrix AC-DC Current	71	Approved on 18 October 2004
AC current up to 100 A: sources	Multifunction calibrator, transconductance amplifier	Direct measurement	0.001	10	A	Frequency	40 Hz to 10 kHz	70 to 220	µA/A	2	95%	Yes	Matrix ACI source	72	Approved on 18 October 2004
AC current up to 100 A: meters	Multimeters: AC current	Direct measurement	0.001	10	A	Frequency	40 Hz to 10 kHz	165 to 6500	µA/A	2	95%	Yes	Matrix ACI meter	73	Approved on 18 October 2004
AC power and energy: single phase at frequencies below 400 Hz	Power meter, wattmeter, power converter	Direct comparison	0.15	1.2E+03	W	Power factor	0.25 to 1	50	µW/VA	2	95%	Yes		74	Approved on 18 October 2004
						Voltage	60 V to 240 V								
						Current	0.01 A to 5 A								
						Frequency	45 Hz to 65 Hz								
AC power and energy: single phase at frequencies below 400 Hz	Energy meter	Direct comparison	3	1.2E+05	Js	Power factor	0.25 to 1	90	µJ/VAs	2	95%	Yes		75	Approved on 18 October 2004
						Voltage	120 V to 240 V								

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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						Current	0.1 A to 5 A								
						Frequency	50 Hz to 60 Hz								
						Measurement time	1 s to 100 s								
AC power and energy: three phase	Energy meter	Direct comparison	2.5	1.2E+05	J	Power factor	0.25 to 1	400	μJ/VAs	2	95%	Yes		76	Approved on 18 October 2004
						Voltage per phase	100 V to 240 V								
						Current per phase	0.1 A to 5 A								
						Frequency	50 Hz to 60 Hz								
						Measurement time	1 s to 100 s								
AC power and energy: three phase	Power meter, wattmeter	Direct comparison	1.8	1.2E+03	W	Power factor	0.3 to 1	100	μW/VA	2	95%	Yes		77	Approved on 18 October 2004
						Voltage per phase	60 V to 240 V								
						Current per phase	0.1 A to 5 A								
						Frequency	45 Hz to 65 Hz								
High DC voltage: high voltage sources	DC kilovolt source	Divided voltage measurement	2	100	kV			170	μV/V	2	95%	Yes		78	Approved on 18 October 2004
High DC voltage: high voltage meters	DC kilovoltmeter	Comparison with divided voltage	2	100	kV			170	μV/V	2	95%	Yes		79	Approved on 18 October 2004
High DC voltage: ratios	High voltage resistive divider, DC high voltage probe	Ratio calibration at low voltage	1E-05	1E-04		Maximum input voltage	100 kV	150	μV/V	2	95%	Yes		80	Approved on 18 October 2004
Magnetic fields below 50 kHz: magnetic flux	Fluxmeter	Fluxmeter, voltage-time integral	0.01	10	Wb	Sampling frequency	100 Hz	5	mWb/Wb	2	95%	Yes		81	Approved on 18 October 2004
						Voltage	1 V								
Magnetic fields below 50 kHz: magnetic flux	Fluxmeter	Fluxmeter, voltage-time integral	0.0001	0.1	Wb	Sampling frequency	100 Hz	5	mWb/Wb	2	95%	Yes		82	Approved on 18 October 2004
						Voltage	10 mV								
Magnetic fields below 50 kHz: DC magnetic flux density and applied magnetic field strength	Magnetometer, solenoid coil, Helmholtz coil, electromagnet	Nuclear Magnetic Resonance (NMR), electromagnet	0.3	2.5	T	Resonance frequency	10 MHz to 150 MHz	5	μT/T	2	95%	Yes		83	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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Magnetic fields below 50 kHz: DC magnetic flux density and applied magnetic field strength	Magnetometer, solenoid coil, Helmholtz coil, electromagnet	Nuclear Magnetic Resonance (NMR), electromagnet	0.04	0.5	T	Resonance frequency	1 MHz to 30 MHz	5	μT/T	2	95%	Yes		84	Approved on 18 October 2004
Magnetic fields below 50 kHz: DC magnetic flux density and applied magnetic field strength	Magnetometer, solenoid coil, Helmholtz coil	Helium-4 Atomic Magnetic Resonance (AMR), Helmholtz coil	1	25	mT	Resonance frequency	3 MHz to 300 MHz	0.25	mT/T	2	95%	Yes		85	Approved on 18 October 2004
Magnetic fields below 50 kHz: DC magnetic flux density and applied magnetic field strength	Magnetometer, solenoid coil, Helmholtz coil	Helium-4 Atomic Magnetic Resonance (AMR), Helmholtz coil	0.05	1.2	mT	Resonance frequency	1 MHz to 50 MHz	4	nT	2	95%	No		86	Approved on 18 October 2004
Magnetic fields below 50 kHz: DC magnetic flux density and applied magnetic field strength	Reference magnet with air gap	Hall magnetometer, NMR, AMR	0.001	0.5	T	Minimum air gap size	2 mm	2	mT/T	2	95%	Yes		87	Approved on 18 October 2004
Magnetic fields below 50 kHz: AC magnetic flux density and applied magnetic field strength	Field generator, AC magnetometer	Direct comparison with search coil	0.001	1	mT	Frequency	0.1 kHz to 1 kHz	2	mT/T	2	95%	Yes		87a	Approved on 18 October 2004
Magnetic fields below 50 kHz: AC magnetic flux density and applied magnetic field strength	Field generator, AC magnetometer	Direct comparison with search coil	0.001	0.8	mT	Frequency	1 kHz to 5 kHz	3	mT/T	2	95%	Yes		87b	Approved on 18 October 2004
Magnetic fields below 50 kHz: AC magnetic flux density and applied magnetic field strength	Field generator, AC magnetometer	Direct comparison with search coil	0.001	0.5	mT	Frequency	5 kHz to 20 kHz	5	mT/T	2	95%	Yes		87c	Approved on 18 October 2004
Magnetic fields below 50 kHz: DC shielding factor (ratio of DC magnetic flux density)	Magnetic shell, shielding factor in DC field	Helium-4 AMR, Cesium AMR, fluxgate magnetometer, non-magnetic facilities	0	80	dB	Maximum field	1 mT	10	dB	2	95%	No		88	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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						Shell size	less than a sphere of 15 cm in diameter								
Magnetic fields below 50 kHz: turn area (ratio of magnetic flux and magnetic flux density)	Sensing coils, area turns	Fluxmeter, NMR	0.005	0.3	m ²	Coil size	smaller than a square of side length 10 cm	50	cm ² /m ²	2	95%	Yes		89	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: electric field strength	Field probe	TEM cell	1	300	V/m	Frequency	10 kHz to 150 MHz	1	dB	2	95%	Yes		90	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: electric field strength	Field probe	TEM cell	1	600	V/m	Frequency	10 kHz to 300 MHz	1	dB	2	95%	Yes		91	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: electric field strength	Field probe	Anechoic chamber	1	60	V/m	Frequency	0.2 GHz to 1.1 GHz	1	dB	2	95%	Yes		92	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: electric field strength	Field probe	Anechoic chamber	1	30	V/m	Frequency	0.4 GHz to 18 GHz	1	dB	2	95%	Yes		93	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: magnetic field strength	Field probe	TEM cell	0.003	0.8	A/m	Frequency	10 kHz to 150 MHz	1.5	dB	2	95%	Yes		94	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: magnetic field strength	Field probe	TEM cell	0.003	1.6	A/m	Frequency	10 kHz to 300 MHz	1.5	dB	2	95%	Yes		95	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: power flux density	Field probe	Anechoic chamber	0.003	9	W/m ²	Frequency	0.2 GHz to 1.1 GHz	1	dB	2	95%	Yes		96	Approved on 18 October 2004
Electromagnetic fields above 50 kHz: power flux density	Field probe	Anechoic chamber	0.003	9	W/m ²	Frequency	0.4 - 18 GHz	1	dB	2	95%	Yes		97	Approved on 18 October 2004
RF power: absolute power on coaxials	Power meter	Power transfer	1E-06	50	W	Frequency	1 MHz to 1 GHz	1 to 1.5	%	2	95%	Yes	Matrix RF Power(1)	98-99	Approved on 18 October 2004
RF power: calibration factor and effective efficiency on coaxials	Power sensor: 50 Ω, Type-N	DC substitution	0.9	1		Frequency	100 kHz to 18 GHz	1	%	2	95%	No		100	Approved on 18 October 2004
RF power: calibration factor and effective efficiency on coaxials	Power sensor: 50 Ω, PC-7	DC substitution	0.9	1		Frequency	100 kHz to 18 GHz	1	%	2	95%	No		101	Approved on 18 October 2004
RF power: calibration factor and effective efficiency on waveguides	Power sensor: Waveguides	DC substitution	0.9	1		Frequency	8.2 GHz to 40 GHz	1 - 1.5	%	2	95%	No	Matrix RF Power(2)	102-105	Approved on 18 October 2004

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



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Scalar RF reflection coefficient and attenuation: attenuation on coaxials	Passive device	Direct substitution	0	90	dB	Frequency	30 MHz	0.001 to 0.01	dB	2	95%	No		106	Approved on 18 October 2004
Scalar RF reflection coefficient and attenuation: attenuation on coaxials	Passive device	IF substitution	0	90	dB	Frequency	10 MHz to 18 GHz	0.015 to 0.06	dB	2	95%	No		107-108	Approved on 18 October 2004
Scattering parameters: reflection coefficient (Sii) on coaxials	Passive device: 50 Ω, Type-N	Vector network analyzer	0	1		Frequency	45 MHz to 18 GHz	0.041		2	95%	No		109	Approved on 18 October 2004
Scattering parameters: reflection coefficient (Sii) on coaxials	Passive device: 50 Ω, PC-7	Vector network analyzer	0	1		Frequency	45 MHz to 18 GHz	0.013		2	95%	No		110	Approved on 18 October 2004
Scattering parameters: reflection coefficient (Sii) on coaxials	Passive device: 50 Ω, 3.5 mm	Vector network analyzer	0	1		Frequency	45 MHz to 26.5 GHz	0.02		2	95%	No		111	Approved on 18 October 2004
Scattering parameters: reflection coefficient (Sii) on coaxials	Passive device: 50 Ω, 2.4 mm	Vector network analyzer	0	1		Frequency	45 MHz to 40 GHz	0.044		2	95%	No		112	Approved on 18 October 2004
Scattering parameters: reflection coefficient (Sii) on waveguides	Passive device: Waveguides	Vector network analyzer	0	1		Frequency	8.2 GHz to 40 GHz	0.01 to 0.013		2	95%	No	Matrix RF Impedance(1)	113-116	Approved on 18 October 2004
Scattering parameters: transmission coefficient (Sij) on coaxials	Passive device: 50 Ω, Type-N	Vector network analyzer	0.0032	1		Frequency	45 MHz to 18 GHz	0.39	dB	2	95%	Yes		117	Approved on 18 October 2004 0 dB to -50 dB
Scattering parameters: transmission coefficient (Sij) on coaxials	Passive device: 50 Ω, PC-7	Vector network analyzer	0.0032	1		Frequency	45 MHz to 18 GHz	0.39	dB	2	95%	Yes		118	Approved on 18 October 2004 0 dB to -50 dB
Scattering parameters: transmission coefficient (Sij) on coaxials	Passive device: 50 Ω, 3.5 mm	Vector network analyzer	0.0032	1		Frequency	45 MHz to 26.5 GHz	0.4	dB	2	95%	Yes		119	Approved on 18 October 2004 0 dB to -50 dB
Scattering parameters: transmission coefficient (Sij) on coaxials	Passive device: 50 Ω, 2.4 mm	Vector network analyzer	0.0032	1		Frequency	45 MHz to 40 GHz	0.87	dB	2	95%	Yes		120	Approved on 18 October 2004 0 dB to -50 dB
Scattering parameters: transmission coefficient (Sij) on waveguides	Passive device: Waveguides	Vector network analyzer	0.0032	1		Frequency	8.2 GHz to 40 GHz	0.077 to 0.33	dB	2	95%	Yes	Matrix RF Impedance(2)	121-124	Approved on 18 October 2004 0 dB to -50 dB

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	NMI service identifier	Comments
Noise: noise temperature or excess noise ratio in coaxials	Noise source	Radiometer	5	17	dB	Frequency	10 MHz to 18 GHz	0.3	dB	2	95%	No		125	Approved on 18 October 2004
Noise: noise temperature or excess noise ratio in waveguides	Noise source: R100	Radiometer	5	17	dB	Frequency	8.2 GHz to 12.4 GHz	0.1	dB	2	95%	No		126	Approved on 18 October 2004
Noise: noise temperature or excess noise ratio in waveguides	Noise source: R140	Radiometer	5	17	dB	Frequency	12.4 GHz to 18 GHz	0.1	dB	2	95%	No		127	Approved on 18 October 2004
Antenna properties: antenna factor	Dipole antenna	Standard antenna method	-5	40	dB/m	Frequency	30 MHz to 1000 MHz	20	%	2	95%	Yes		128	Approved on 18 October 2004
Antenna properties: antenna factor	Biconical antenna	Standard antenna method	-5	40	dB/m	Frequency	30 MHz to 300 MHz	20	%	2	95%	Yes		129	Approved on 18 October 2004
Antenna properties: antenna factor	Log periodic antenna	Standard antenna method	-5	40	dB/m	Frequency	200 MHz to 1000 MHz	20	%	2	95%	Yes		130	Approved on 18 October 2004
Antenna properties: antenna factor	Rod antenna	Standard field method	-5	90	dB/m	Frequency	10 kHz to 300 MHz	20	%	2	95%	Yes		131	Approved on 18 October 2004
Antenna properties: antenna factor	Loop antenna	Standard field method	-5	90	dB/m	Frequency	10 kHz to 30 MHz	10	%	2	95%	Yes		132	Approved on 18 October 2004
Antenna properties: antenna gain	OEG antenna	Three antenna method	0	10	dB	Frequency	0.5 GHz to 1.1 GHz	1	dB	2	95%	No		133	Approved on 18 October 2004
Antenna properties: antenna gain	Horn antenna	Three antenna method	10	30	dB	Frequency	0.5 GHz to 40 GHz	0.5 to 1	dB	2	95%	No		134	Approved on 18 October 2004
RF voltage and current: RF-DC difference	Thermal voltage converter: RF voltmeter	Direct comparison	0	0.2		Frequency	1 MHz to 1 GHz	1	%	2	95%	No		135	Approved on 18 October 2004
RF voltage and current: RF-DC difference	Thermal voltage converter: RF voltmeter	Direct comparison	0	0.1		Frequency	1 MHz to 100 MHz	1	%	2	95%	No		136	Approved on 18 October 2004
Soft magnetic bulk materials: magnetic polarisation	Bulk soft magnetic material, ring samples, according to IEC 60404-4	Hysteresis loop	0.1	2.1	T	Magnetic field strength	1 A/m to 10 kA/m	20	mT/T	2	95%	Yes		137	Approved on 18 October 2004 The measurand range depends on materials
						Temperature	18 °C to 28 °C								

Electricity and Magnetism, Republic of Korea, KRISS (Korea Research Institute of Standards and Science)



Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	NMI service identifier	Comments
Soft magnetic bulk materials: magnetic field strength	Bulk soft magnetic material, ring samples, according to IEC 60404-4	Hysteresis loop	100	10000	A/m	Magnetic flux density	0.1 T to 2.1 T	2E-02	(A/m)/(A/m)	2	95%	Yes		138	Approved on 18 October 2004 The measurand range depends on materials
						Temperature	18 °C to 28 °C								
Soft magnetic bulk materials: remanent flux density	Bulk soft magnetic material, ring samples, according to IEC 60404-4	Hysteresis loop	0.5	2	T	Temperature	18 °C to 28 °C	20	mT/T	2	95%	Yes		139	Approved on 18 October 2004 The measurand range depends on materials
Soft magnetic bulk materials: coercive field strength	Bulk soft magnetic material, ring samples, according to IEC 60404-4	Hysteresis loop	100	1000	A/m	Temperature	18 °C to 28 °C	0.02	(A/m)/(A/m)	2	95%	Yes		140	Approved on 18 October 2004
Hard magnetic material: remanent magnetic flux density	Permanent magnetic material, cylinder or parallelepiped, according IEC60404-5	Hysteresis loop	0.1	1.8	T	Temperature	18 °C to 28 °C	20	mT/T	2	95%	Yes		141	Approved on 18 October 2004
Hard magnetic material: coercive field strength H_{cB}	Permanent magnetic material, cylinder or parallelepiped, according IEC60404-5	Hysteresis loop	10	1600	kA/m	Temperature	18 °C to 28 °C	0.02	(A/m)/(A/m)	2	95%	Yes		142	Approved on 18 October 2004
Hard magnetic material: coercive field strength H_{cJ}	Permanent magnetic material, cylinder or parallelepiped, according IEC60404-5	Hysteresis loop	10	1600	kA/m	Temperature	18 °C to 28 °C	0.02	(A/m)/(A/m)	2	95%	Yes		143	Approved on 18 October 2004
Hard magnetic material: energy product (BH)max	Permanent magnetic material, cylinder or parallelepiped, according IEC60404-5	Hysteresis loop	5	500	kJ/m ³	Temperature	18 °C to 28 °C	0.03	(A/m)/(A/m)	2	95%	Yes		144	Approved on 18 October 2004

Electricity and Magnetism, Korea, KRISS (Korea Research Institute of Standards and Science)

Uncertainty matrix: Matrix AC-DC Voltage

AC/DC voltage transfer: AC/DC difference at low voltages. Internal identifier: 52, 53 and 54-66

	40 Hz	500 Hz to 10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	500 kHz	700 kHz	1 MHz
0.2 V	15	15	15	15	15	20	25	35	40
0.5 V	10	10	10	10	10	15	20	35	35
1 V	5	5	5	5	5	10	15	25	25
2 V	3	3	3	4	4	10	15	25	25
4 V	4	4	4	5	5	10	15	25	25
6 V	5	5	5	6	6	10	15	25	25
10 V / 12 V	7	7	7	7	7	10	15	25	25
20 V	8	8	8	8	8	10	15	25	25
30 V	8	8	8	9	9	10	15	-	-
40 V	9	9	9	9	9	10	15	-	-
60 V	10	10	10	10	10	15	-	-	-
100 V	13	13	13	16	20	-	-	-	-
120 V	15	15	15	18	25	-	-	-	-
200 V	17	17	17	20	25	-	-	-	-
300 V / 400 V	20	20	20	25	25	-	-	-	-
500 V / 600 V	25	25	25	35	50	-	-	-	-
1000 V	30	30	40	50	-	-	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

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Uncertainty matrix: Matrix ACV source

AC/DC voltage transfer: AC/DC difference at higher voltages. Internal identifier: 67

	40 Hz to 10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	500 kHz	1 MHz
0.1 V	40	40	62	62	235	240	335
1 V	40	40	40	45	85	120	120
10 V	40	40	40	45	85	120	120
100 V	40	40	40	65	-	-	-
1000 V	40	45	-	-	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

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Uncertainty matrix: Matrix ACV meter

AC voltage up to 1000 V: meter. Internal identifier: 68

	40 Hz to 20 kHz	21 kHz to 50 kHz	51 kHz to 100 kHz	50 Hz to 1 kHz	1.1 kHz to 20 kHz
100 mV	160	274	655	-	-
1 V	64	91	147	-	-
10 V	61	91	128	-	-
100 V	68	100	173	-	-
1000 V	-	-	-	77	140

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

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Uncertainty matrix: Matrix AC-DC Current

AC-DC current transfer: AC-DC transfer difference. Internal identifier: 71

	40 Hz	500 Hz	1 kHz	10 kHz
5 mA	60	60	60	60
10 mA	60	60	60	60
20 mA	60	60	60	60
30 mA	68	68	68	68
50 mA	68	68	68	68
100 mA	68	68	68	68
200 mA	77	77	77	77
300 mA	86	86	86	86
500 mA	96	96	96	96
1 A	105	105	105	105
2 A	125	125	125	125
3 A	145	145	145	145
5 A	165	165	165	165
10 A	205	205	205	205

The expanded uncertainties given in this table are expressed in $\mu\text{A/A}$.

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Uncertainty matrix: Matrix ACI source

AC current up to 100 A: source. Internal identifier: 72

	40 Hz	500 Hz	1 kHz	10 kHz
1 mA	70	70	70	70
10 mA	70	70	70	70
100 mA	80	80	80	80
1 A	120	120	120	120
10 A	220	220	220	220

The expanded uncertainties given in this table are expressed in $\mu\text{A/A}$.

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Uncertainty matrix: Matrix ACI meter

AC current up to 100 A: meters. Internal identifier: 73

	40 Hz to 1 kHz	1.1 kHz to 5 kHz	5.1 kHz to 10 kHz
1 mA	165	305	1600
10 mA	165	250	1430
100 mA	165	235	1025
1 A	305	495	6500
10 A	480	935	3450

The expanded uncertainties given in this table are expressed in $\mu\text{A/A}$.

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Uncertainty matrix: Matrix RF Power (1)

RF power: absolute power on coaxials. Internal identifier: 98 - 99

	1 MHz to 1 GHz
0.001 mW	1
0.01 mW	1
0.1 mW	1
1 mW	1
10 mW	1.5
100 mW	1.5
1 W	1.5
10 W	1.5
50 W	1.5

The expanded uncertainties given in this table are expressed in %.

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Uncertainty matrix: Matrix RF Power (2)

RF power (calibration factor and effective efficiency on waveguides). Internal identifier: 102 - 105

	8.2 GHz to 12.4 GHz	12.4 GHz to 18 GHz	18 GHz to 26.5 GHz	26.5 GHz to 40 GHz
0.9	1	1.2	1.5	1.5
1	1	1.2	1.5	1.5

The expanded uncertainties given in this table are expressed in %.

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Uncertainty matrix: Matrix RF Impedance(1)

Scattering parameters (reflection coefficient on waveguides). Internal identifier: 113 - 116

	8.2 GHz to 12.4 GHz	12.4 GHz to 18 GHz	18 GHz to 26.5 GHz	26.5 GHz to 40 GHz
0	0.01	0.01	0.012	0.013
1	0.01	0.01	0.012	0.013

The expanded uncertainties given in this table are dimensionless.

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Uncertainty matrix: Matrix RF Impedance(2)

Scattering parameters (transmission coefficient on waveguides). Internal identifier: 121 - 124

	8.2 GHz to 12.4 GHz	12.4 GHz to 18 GHz	18 GHz to 26.5 GHz	26.5 GHz to 40 GHz
0.0032	0.077	0.082	0.28	0.33
1	0.077	0.082	0.28	0.33

The expanded uncertainties given in this table are expressed in dB.